

# Lower Extremity Injuries to Children Restrained in Motor Vehicle Crashes

**CIREN**

**Children's National Medical Center  
Washington, DC**



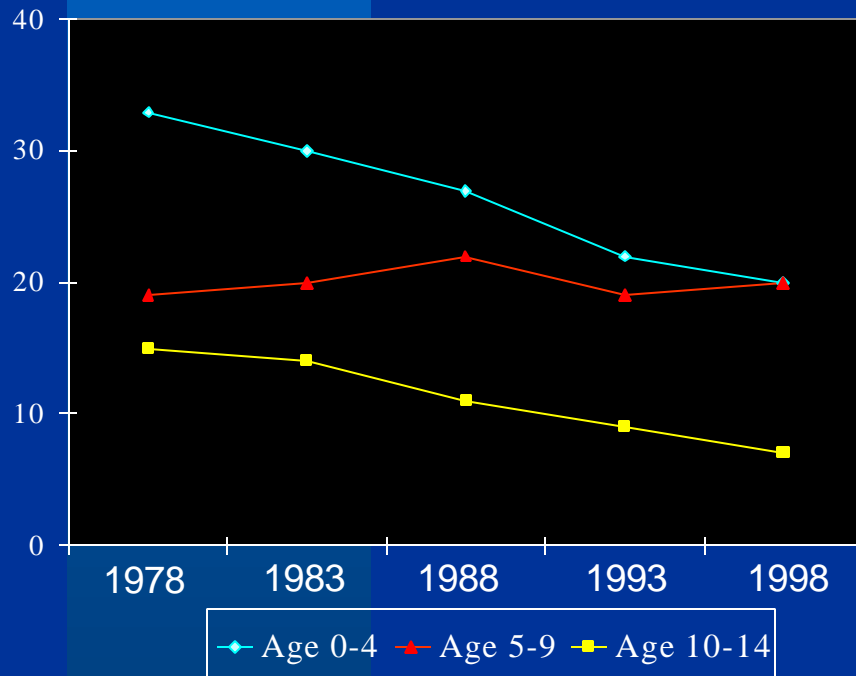
# MVC Epidemiology:

## Child Mortality & Morbidity

- MVC incidence: 1998:
  - 2000 < 16 years old killed
  - Another 360,000 injured

# Trends in MVC Mortality & Morbidity 1978-1998

Rate/100,000



- Children < 5 yrs: 35% decline
- Children 5-9 yrs: unchanged
- Children 10-14 yrs: 15% decline

Source: Traffic Safety Facts 1998, US DOT/NHTSA



# SAFEKids Study:

## Child Restraint Misuse

- 54,000 Attending Check-up Event
- 85% misuse rate
  - 63% seat belt not anchored tightly
  - 33% harness straps not snug
  - 20% harness straps improperly routed
  - 11% forward-facing before age 1 & 20 lbs.

# CNMC Inclusion Criteria

- Admitted to Trauma Service
- Children < 16 Years Old
- Restrained MVC Passengers

# CNMC Exclusion Criteria

- Unrestrained
- ED Treated & Release
- Vehicle > 6 Years Old
- Unable to Locate Vehicle

# Rear-Facing Safety Seats for Infants

- Age < 1 yr &  
Wt < 20 lbs



# Forward-Facing Child Safety Seats

- Age 1-4 yrs &  
Wt < 40 lbs



# Convertible Seats

- Rear-facing for Infants < 20 lbs
- Forward-facing for Children 20-40 lbs



# Booster Seats

- Age > 4 yrs. &  
Wt. 40-80 lbs &  
Ht < 58 in.



## 3-pt Lap/Shoulder Safety Belts

- Seatbelt Readiness:  
Wt. > 80 lbs  
Ht. > 58 in.



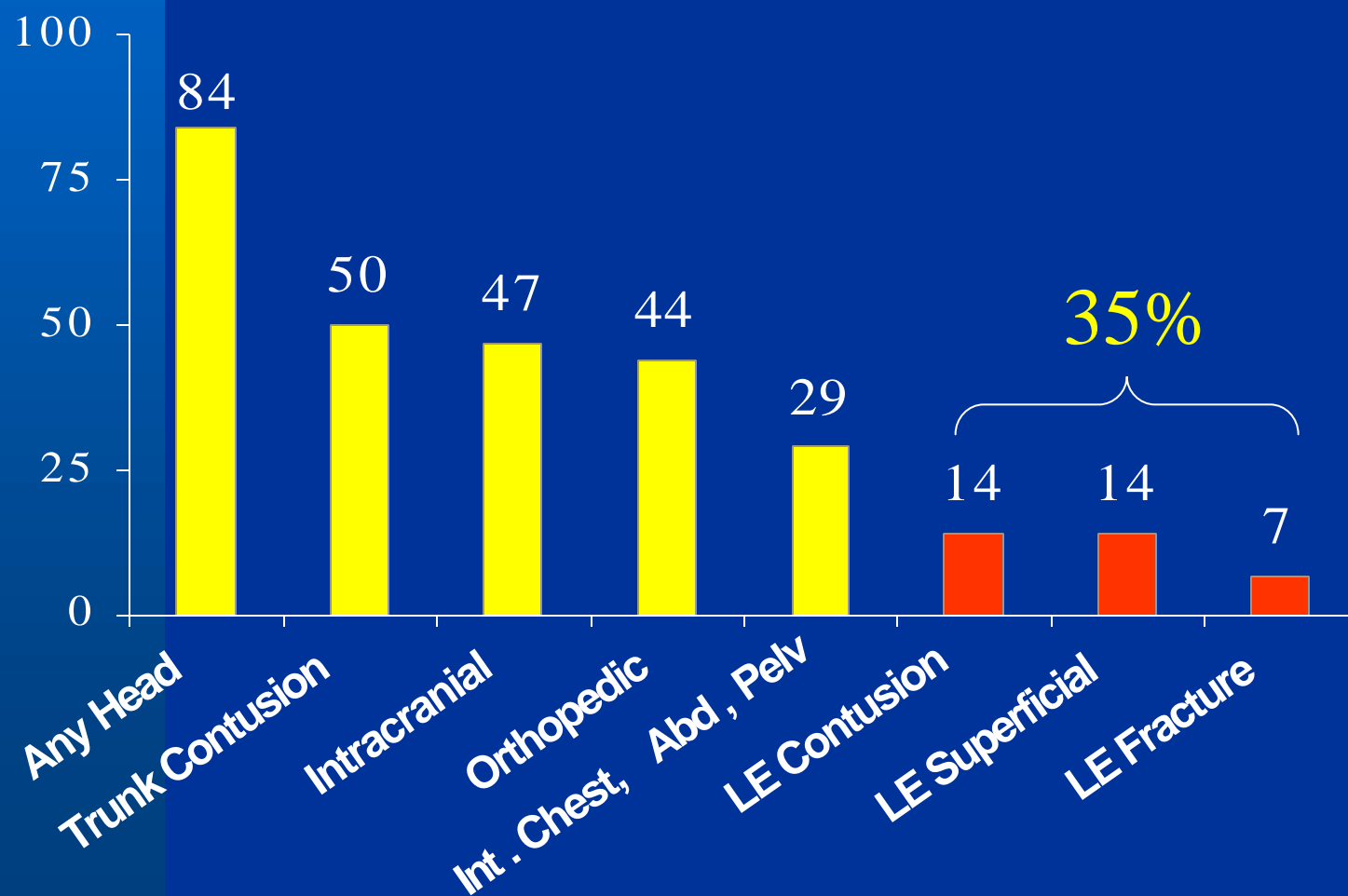
## CNMC Population, 1991-2000

- 194 Cases
  - 54% Female
- Mean age = 6 Years
  - 39% < 5 Years Old
- Median ISS = 6
- Median LOS = 2 days

# Lower Extremity Injury Definition

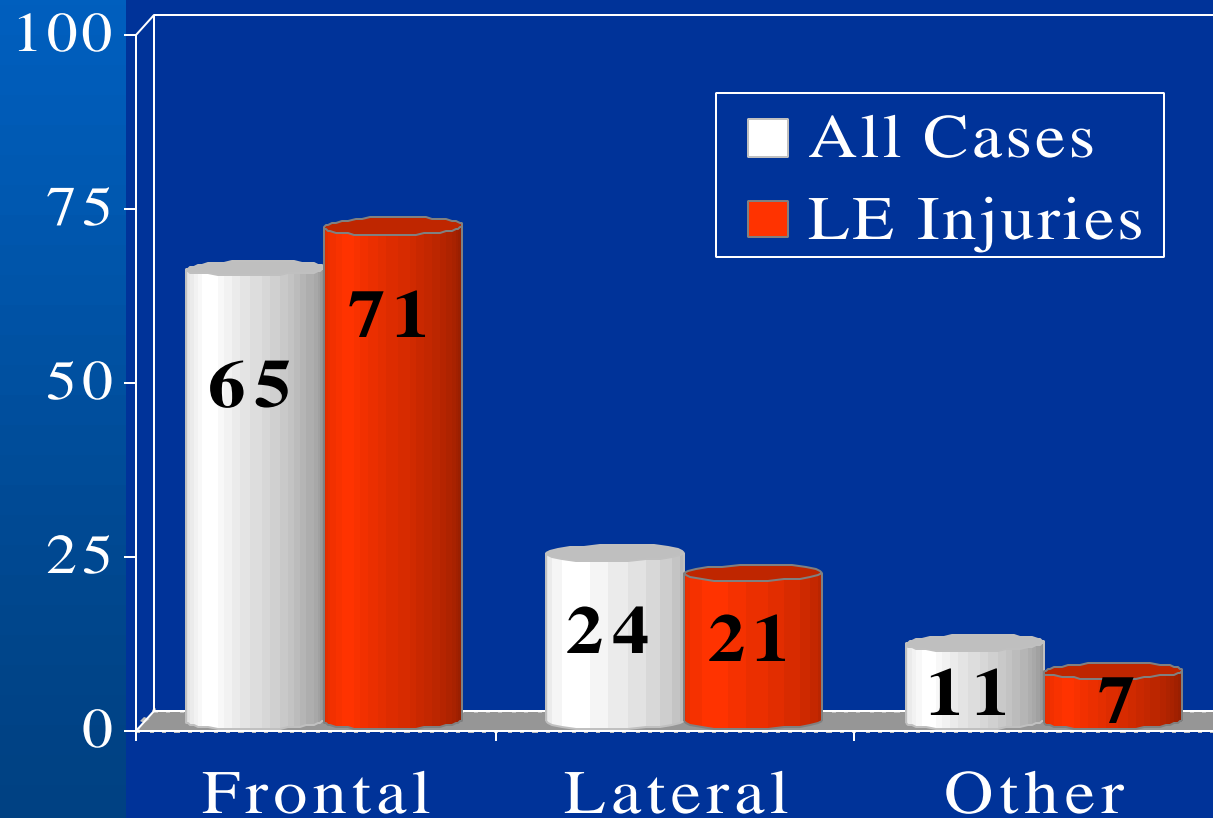
- LE Fx: Lower Extremity Fractures
- LE Non-Fx Cases:
  - Contusions
  - Lacerations
  - Abrasions

## CNMC Injury Diagnoses (n=194)



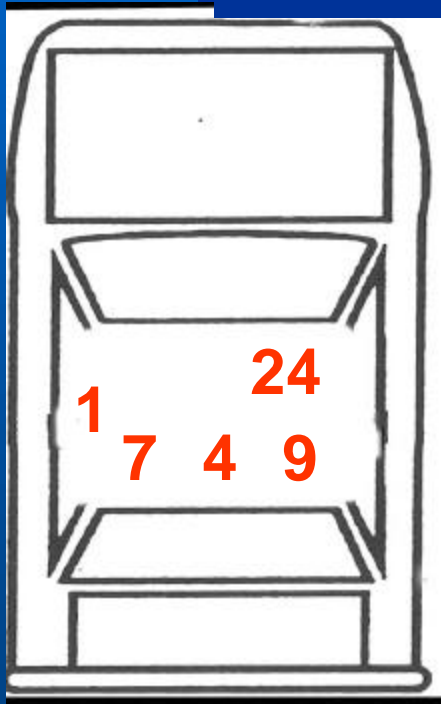
# Lower Extremity Injuries

## Crash Type

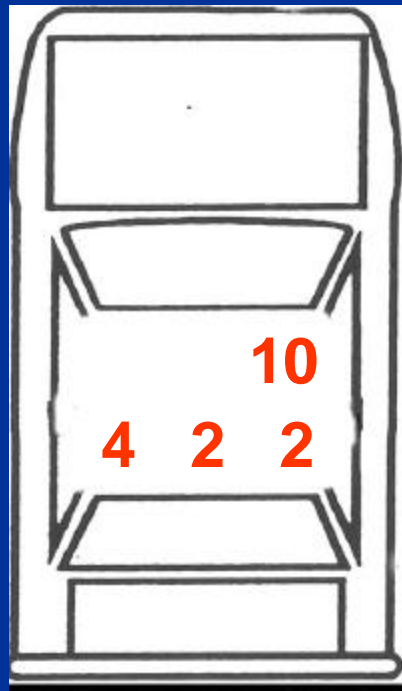


# Lower Extremity Injuries

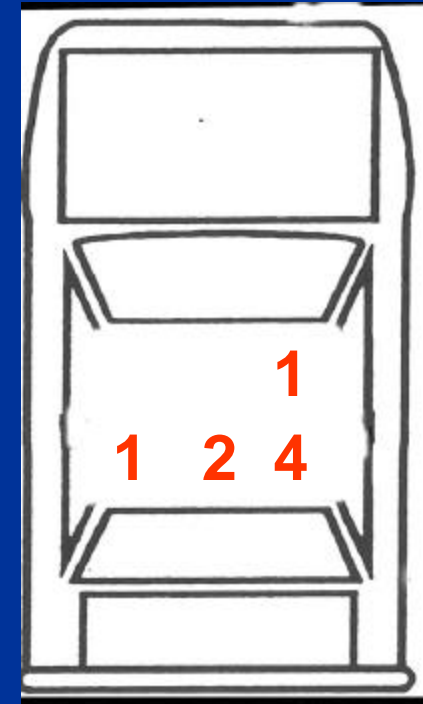
## Crash Type & Seating Position



Frontal  
Crashes  
(n=45)

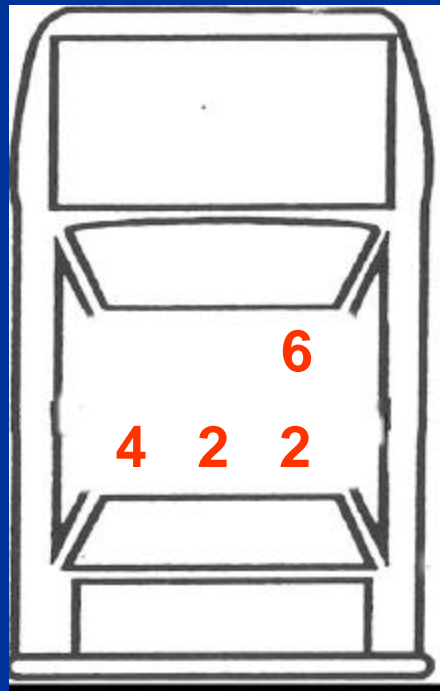


Lateral  
Crashes  
(n=18)

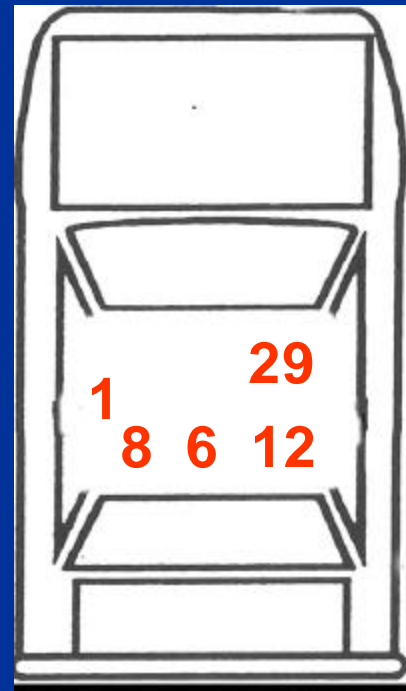


Other  
Crashes  
(n=8)

# Seating Position by Injury Type



LE Fracture  
(n=14)



LE non-Fracture  
(n=57)

# Lower Extremity Injuries

## Patient Demographics

Measure	LE Fx (n=14)	LE non-Fx (n=57)
Sex		
% Female	71%	55%
Age Group		
< 4 yrs	30%	29%
4-8 yrs	45%	21%
> 8 yr	25%	50%
Height (mean)	48 in	44 in
Weight (mean)	62 lb	56 lb
Discharge Disp		
% fatalities	0%	9%

# Femur Fractures

Fracture	AIS	Age	Seat Position	Restraint
7 Femur Fractures	3	3	C Rear	Lap Belt only
	3	3	R Front	3-pt L/S Belt
	3	3	R Rear	Booster Seat
	2	5	L Rear	3-pt L/S Belt
	2	6	L Rear	3-pt L/S Belt
	2	11	R Rear	Lap belt only
	3	12	R Rear	Lap belt only

# Femur Fractures



- 6 yo
- Lap/shoulder
- L Rear
- Proximal Fx

# Femur Fractures



- 3.5 yo
- Lap belt only
- C Rear
- Spiral, Mid-shaft

# Tibia & Metatarsal Fractures

Fracture	AIS	Age	Seat Position	Restraint
Tibia Fx	2	2	L Rear	FF CSS
Tibia Fx	2	6	R Front	3-pt L/S Belt
Metatarsal Fx	2	11	R Front	3-pt L/S Belt

# Tibia Fractures

- 10 yo
- Lap/shoulder Belt
- R Front Seat
- Tibia: Spiral, Comminuted
- Door Intrusion, Airbag



# Multiple Fractures

Fracture	AIS	Age	Seat Position	Restraint
Femur, Tibia, Fibula & Metatarsal Fxs	2, 3, 2, 2	8	L Rear	Lap belt
Femur, Knee & Metatarsal Fxs	3, 3, 2	14	R Front	Shoulder belt
Tibia & Fibula Fxs	3, 2	8	C Rear	Lap belt
Tibia & Toe Fxs	3, 1	10	R Front	Lap belt

# Multiple Fractures



- 8 yo
- Lap Belt Only
- C Rear
- Tibia & Fibula: Comminuted, Mid-shaft

## Source of Contact: Fractures

Contact Source	Injured	Fractures
Seat Back	3	2 Femur, 1 Tibia
Instrument Panel	3	1 Knee, 1 Femur, 1 Tibia
Door Hardware	2	2 Tibia, 2 Femur 1, Fibula, 1 Foot
Toe Pan	2	4 Foot
Booster Shield	1	1 Femur
Lap Belt	1	1 Femur
Floor Console	1	1 Tibia, 1 Fibula
Unknown	1	1 Femur, 4 Foot

# Severity Indicators

Severity Measure	LE Fx (n=14)	LE non-Fx (n=57)
ISS (Median, Range)	10 (1-77)	5 (5-43)
AIS 2+ Injuries (Mean)	2.9	2.2
AIS 3+ Injuries (Mean)	1.5	1.3

# Severity Indicators

Severity Measure	LE Fx (n=14)	LE non-Fx (n=57)
LOS (Median, Range)	3 (1-48)	2 (0-369)
Acute Care Costs (Median, Range)	\$11,289 (3032 - 272,390)	\$6,045 (1164 - 370,122)

# Mean AIS Score by Body Region

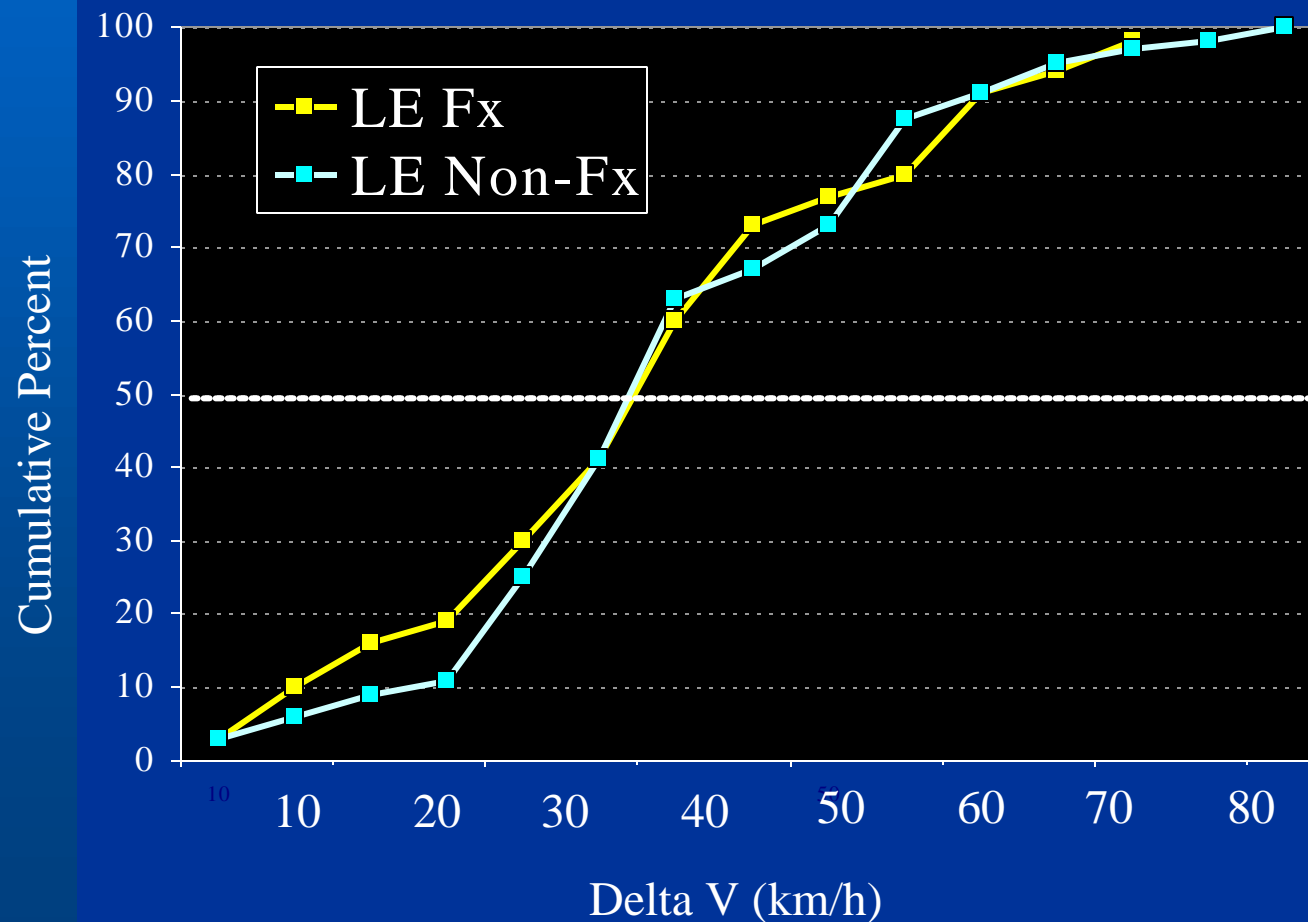
Diagnosis	Head	Face	Chest	Abd. U	Ext.	L Ext.	ISS
LE Fractures	0.7	1.5	0.3	1.6	0.8	3.0	15.5
LE Contusions	3.4	2.1	0.3	1.3	0.8	1.6	14.4
LE Superficials	2.0	1.2	0.2	2.9	0.7	1.3	12.9

## Frequency of Other Injuries

Injury	LE Fx %	LE Non-Fx %
Any Skull Fracture	0%	18%
Any Conc./Cereb. Cont.	7%	23%
Any Internal Chest	18%	21%
Any Spinal Injury	14%	12%
Any Internal Abd./Pelvis	14%	26%

# Cumulative Probability of Injury

## Lower Ext. Injury by Delta-V (Frontal)



# Child Restraint Used

Restraint	LE Fx N (%)	LE non-Fx N (%)
RF Infant Seat	0 ( 0)	5 ( 9)
FF Child Safety Seat	1 ( 7)	7 (12)
Booster Seat	1 ( 7)	2 ( 4)
Lap/Shoulder Belt	6 (43)	23 (40)
Lap Belt Only	5 (36)	15 (26)
Shoulder Belt Only	1 ( 7)	5 ( 9)

# Evaluating Restraint Use

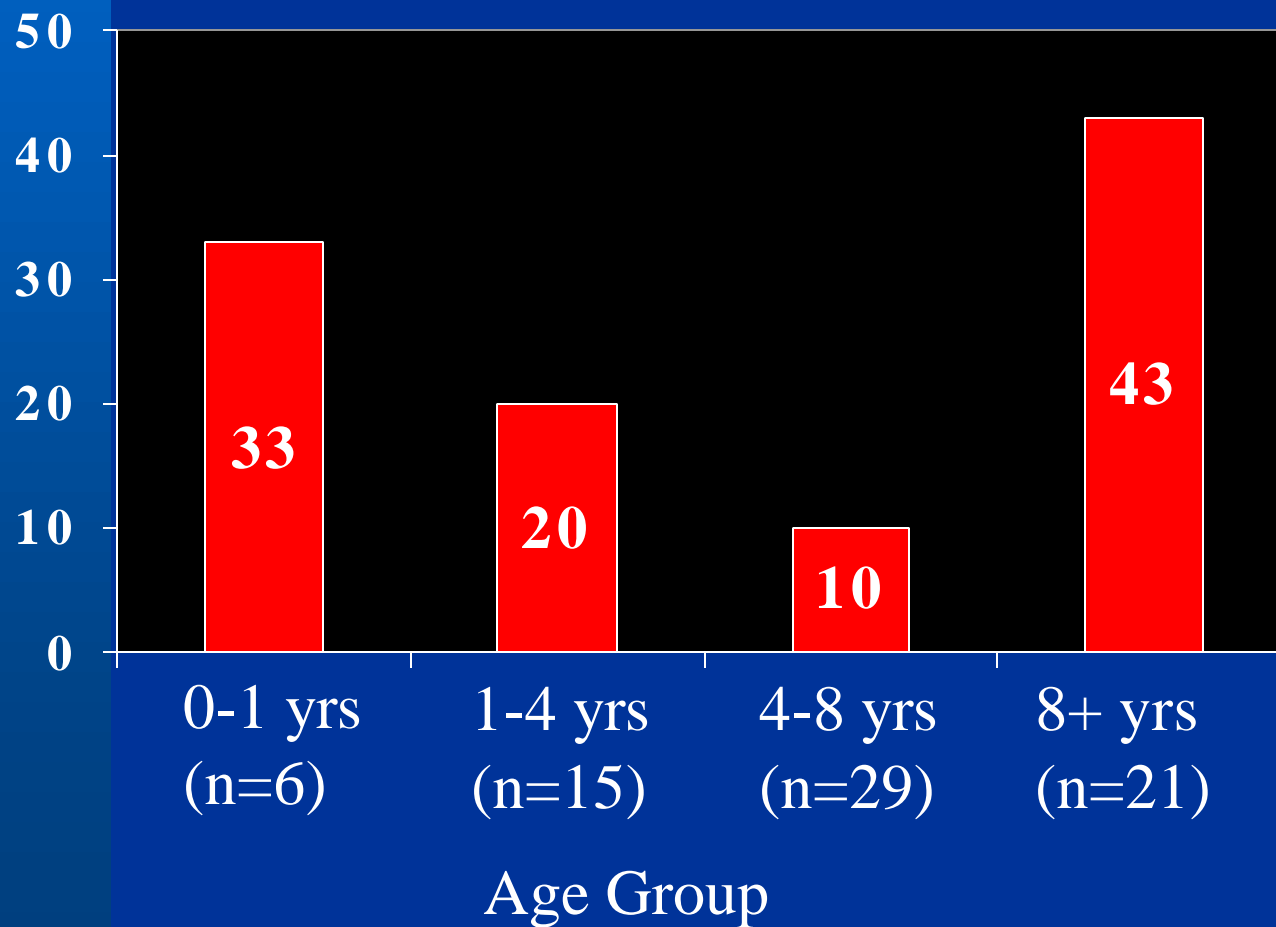
- Appropriate: What Restraint Was Used
  - age, weight, restraint type
- Misuse: How the Restraint Was Used

# Child Restraint Misuse

Misuse	LE Fx (n=14)	LE non-Fx (n=57)
None	57%	44%
Seat Improperly Installed	-	9%
Shoulder Belt Not Worn, Under Arm	19%	21%
Lap Belt Not Worn, Slack	14%	11%

# Child Restraint Use:

% Appropriately Restraint & Not Misused



# Conclusions

- LE Fractures are Infrequent Among Children < 4 yrs of Age Restrained in Child Safety Seats
- Fractures Associated with:
  - Females
  - Spiral, Oblique, Comminuted

# Conclusions

- No Association with:  
Delta V, Crash Type, Seat Position
- LE Injury Increase: Misuse of Belt System & Inappropriate Restraint Type
  - 50% Seated in Right Front
  - 90% 4-8 yrs old & < 80 lbs: No Booster